Sea Ice: Just the Cold Facts

Objectives

- Explore the current views about the relationship between sea ice and global climate change
- Calculate the seasonal change of sea ice in the polar regions
- Compare and contrast the extent of sea ice in the Arctic and Antarctic

Rationale

See NASA Fact Sheet "Polar Ice"

Grade Level/Discipline

Middle and High School, Physical Science, Earth Science, Physics, Math

Teacher Preparation for Activity

Materials

- NASA Fact Sheet "Polar Ice"
- March 1986 and September 1986 Arctic Sea Ice Maps
- March 1986 and September 1986 Antarctic Sea Ice Maps
- Graph Paper
- Atlas

Time Frame

1 Class Period

Predictions

1. During which month would you expect sea ice in the Arctic to be at its maximum? Antarctic?
2. In which polar area would you expect the greatest amount of sea ice?
3. Look at location maps for the north and south polar regions (atlas). How could geographical differences in the north and south polar regions influence sea ice production?

Procedure

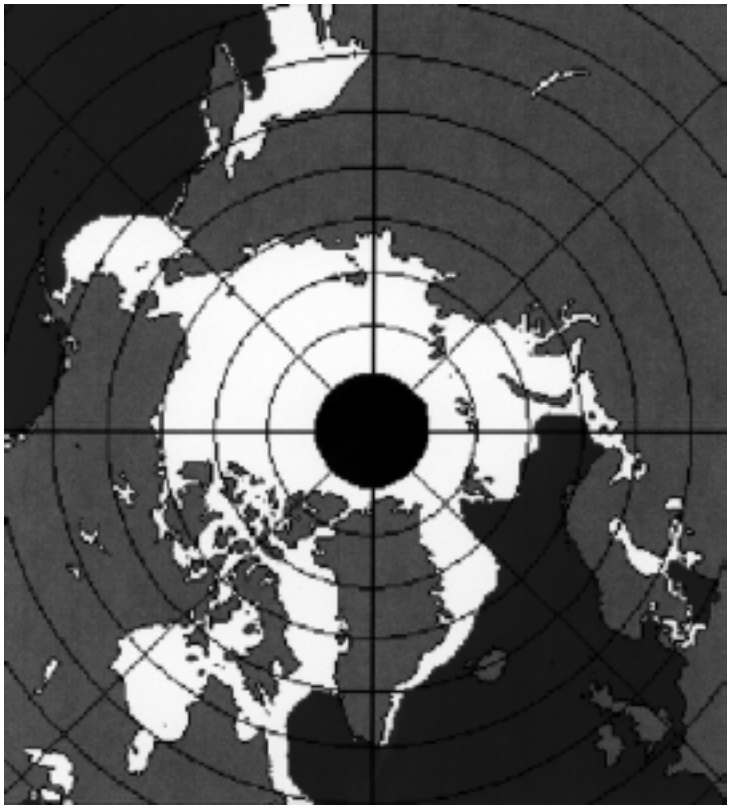
1. Read the NASA Fact Sheet on "Polar Ice".
2. Using an atlas, identify the Arctic and Antarctic maps and label them.
3. Overlay the graph paper on the satellite maps and count/record the number of squares occupied by sea ice. Ice is represented by the white areas in each of the maps.
4. Fill in your data in the area below and answer the Evaluation Questions.

Data

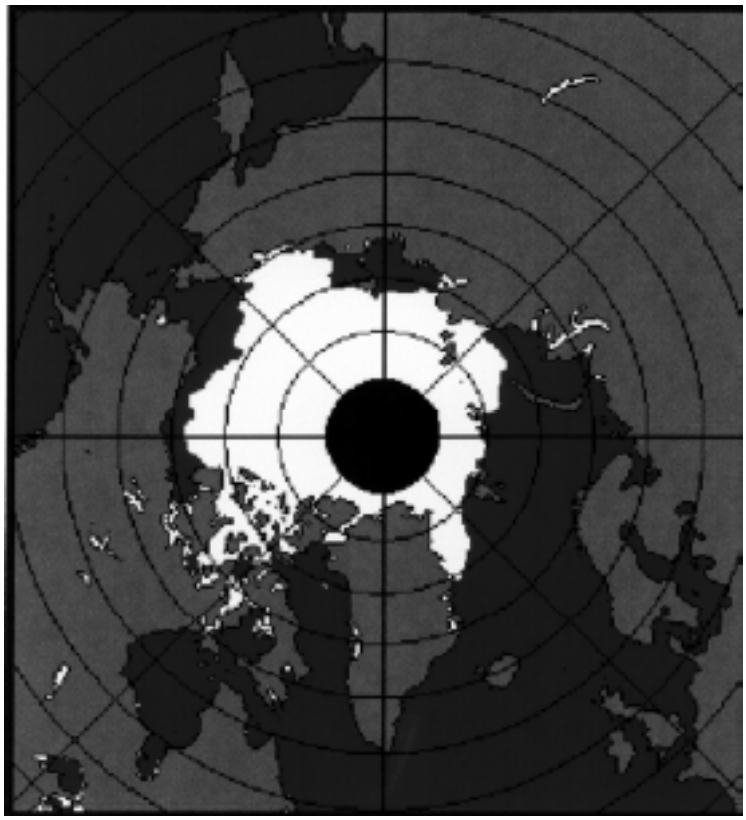
1. Arctic sea ice in March 1986 =
2. Arctic sea ice in September 1986 =
3. % change of sea ice in the Arctic =
4. Antarctic sea ice in March 1986 =

5. Antarctic sea ice in September 1986 =
6. % change of sea ice in the Antarctic =
7. % difference between the Arctic and Antarctic winter (March and September, respectively) ice coverages =

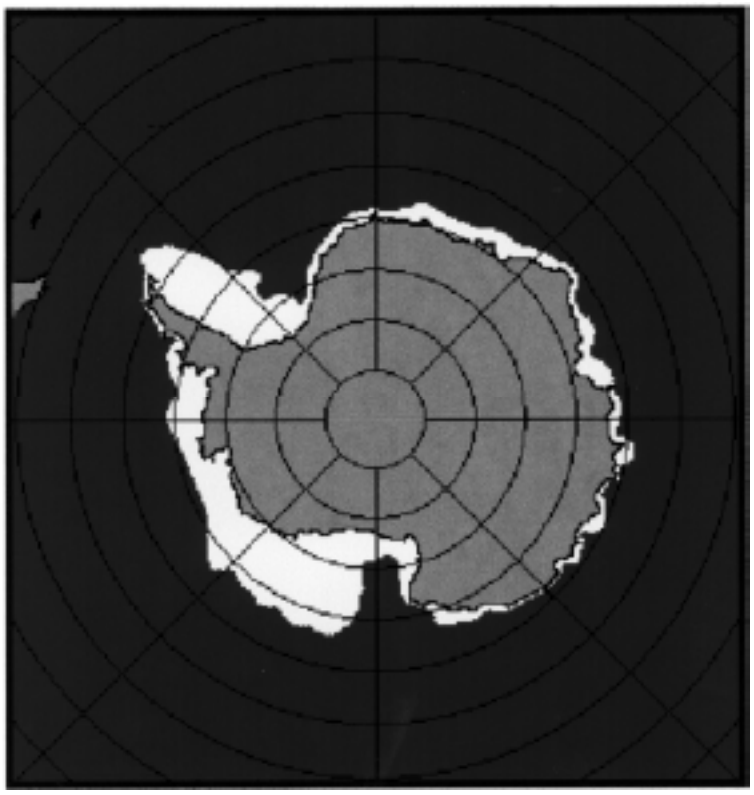
March 1986



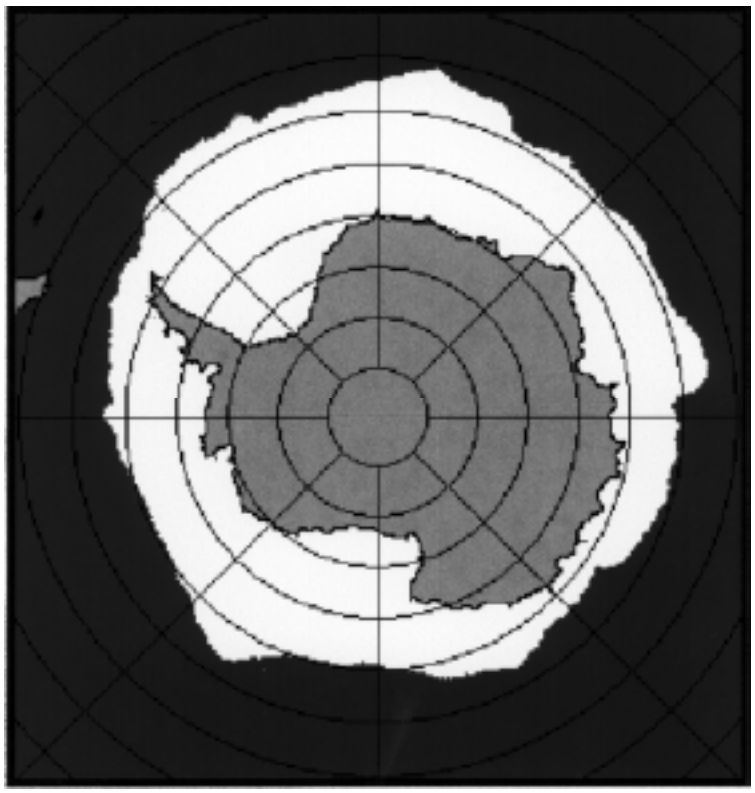
September 1986



March 1986 (Top)



September 1986



Evaluation

1. Of the maps provided, during which month is sea ice coverage greatest in the Arctic? Antarctic?

2. Which polar region had the greatest total sea ice coverage? Compare to your prediction.

3. What factors could account for the difference in sea ice coverage between the polar regions? Compare to your prediction.

4. Which instruments are used to measure sea ice extents?

5. Some climate scientists think that rising sea level would be a consequence of greenhouse warming, because of the melting of land ice. Although sea ice, which forms from ocean water, does not affect sea level, what mechanisms connect sea ice and temperatures?

Evaluation: Suggested Answers

1. The number of squares will vary depending on the size of the squares on the graph paper. Arctic sea ice is at its maximum in March (end of the Northern Hemisphere winter). Antarctic sea ice is at its maximum in September (end of Southern Hemisphere winter).

2. The Antarctic region has the greatest maximum sea ice coverage (~19 million km^2 in September), but the Arctic region has the greatest minimum sea ice coverage at approximately 9 million km^2 in September. Arctic maximum sea ice coverage is approximately 15 million km^2 in March. Antarctic minimum sea ice coverage is approximately 4 million km^2 in February. At its maximum, the Arctic is only 79% of the maximum coverage of the Antarctic.

3. The difference between the Arctic and Antarctic sea ice coverage is due to the geography. The area in the central polar region of the Arctic is ocean, bounded largely by the continents of the Northern Hemisphere. The continental boundaries limit the extent to which Arctic sea ice can grow during the cold months. In contrast, sea ice in the Southern Hemisphere has no land boundaries to the north to limit the winter's sea ice growth. In the summer, geography again plays a role in sea ice coverage. In the Arctic, the highest-latitude region is covered by ocean. Arctic sea ice shrinks less than Antarctic sea ice in the summer because it lies in an area that stays very cold. The Earth's south polar region on the other hand, is covered by the continent of Antarctica. Sea ice extends from the coast of the continent, which is further away from the extreme cold in central Antarctica.

4. Data are now collected from the Special Sensor Microwave/Imager (SSM/I). Earlier instruments include the Electrically Scanning Microwave Radiometer (ESMR) and the Scanning Multichannel Microwave Radiometer (SMMR). An instrument now being built is the Advanced Microwave Scanning Radiometer (AMSR) which is scheduled for flight on the EOS PM satellite. Each of these instruments is a passive microwave radiometer, all of which measure microwave radiation given off by objects in the instrument's field of view. Active instruments, like radars, actually send out a signal which they later receive back.

5. Scientists have measured a global climate change of 0.3 to 0.6 °C over the last 100 years (from the Intergovernmental Panel on Climate Change) and predict further warming in the future. Possible contributions to warming include any reduction in the

amount of sea ice coverage and/or any decrease in the amount of time sea ice covers certain areas. Both of these scenarios would lead to a positive feedback. Less sea ice translates into less solar radiation reflected, which would warm the climate and therefore lead to even less sea ice. A greater direct ocean-atmosphere interface uninterrupted by sea ice would cause an increased heat transfer, especially in the polar winter when the water temperature is often considerably warmer than the air temperature. Conversely, increased sea ice coverage would encourage cooling.

Authors

Originally developed for the Teacher's Guide to accompany NASA's Earth Observing System CD-ROM by Susan Lower, Roosevelt High School, Greenbelt, Md. This was done under the direction of Dr. Claire Parkinson, NASA Goddard Space Flight Center, who suggested the concept for the exercise, provided the figures, and provided the Evaluation Suggested Answers.

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